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PATENT APPLICATION
TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No. 140315.92289

First Inventor or Application Identifier Thornborough

Title METERING PULSE TRANSDUCER

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APPLICATION ELEMENTS

See MPEP Chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, D.C. 202311 ☒ Fee transmittal Form
(Submit an original and a duplicate for fee processing)6. ☐ Microfiche Computer Program (Appendix)2 ☒ Specification [Total Pages 14]
(preferred arrangement set forth below)7. Nucleotide and/or Amino Acid Sequence Submission
(if applicable, all necessary)

- Descriptive title of the invention
- Cross References to Related Applications
- Statement Regarding Fed Sponsored R&D
- Reference to Microfiche Appendix
- Background of the Invention
- Brief Summary of the Invention
- Brief Description of the Drawings (if filed)
- Detailed Description
- Claim(s)
- Abstract of the Disclosure

- a. ☐ Computer readable Copy
- b. ☐ Paper Copy (identical to computer copy)
- c. ☐ Statement Verifying identity of above

3 ☒ Drawing(s) (35 USC 113) [Total Sheets 7]

4. Oath or Declaration [Total Pages 2]

- a. ☒ Newly executed (original or copy)
- b. ☐ Copy from prior Application (37 CFR 1.63(d))
(for continuation/divisional with Box 17 completed)

[Note Box 5 below]

- i. ☐ DELETION OF INVENTOR(S)
Signed Statement attached deleting
inventor(s) named in prior application,
see 37 CFR 1.63(d)(2) and 1.33(b).

5 ☐ Incorporation By Reference (useable if Box 4b is checked)
The entire disclosure of the prior application from
which a copy of the oath or declaration is supplied
under Box 4b, is considered as being part of the
disclosure of the accompanying application, and is
hereby incorporated by reference herein.

ACCOMPANYING APPLICATION PARTS

- 8 ☒ Assignment Papers (cover sheet & documents)
- 9 ☐ 37 CFR 3.73(b) Statement ☐ Power of Attorney
(where there is an assignee)
- 10 ☐ English Translation Document (if applicable)
- 11 ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
- 12 ☐ Preliminary Amendment
- 13 ☒ Return receipt postcard (MPEP 503)
(Should be specifically itemized)
- 14 ☐ *Small Entity Statement filed in prior application
Statement(s) ☐ Status still proper and desired
- 15 ☐ Certified copy of priority Document(s)
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18. CORRESPONDENCE ADDRESS

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(Insert Customer No. or Attach bar code label)

or ☒ Correspondence address below

NAME

Michael J. McGovern

ADDRESS

Quarles and Brady LLP

411 East Wisconsin Avenue

CITY

Milwaukee

STATE

WI

ZIP CODE

53202-4497

COUNTRY

USA

TELEPHONE

(414) 277-5000

FAX

(414) 271-3552

Name (Print/Type)

Michael J. McGovern

Registration No. (Attorney/Agent)

28,326

Signature

Michael J. McGovern

Date

Dec 27, 1999

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METERING PULSE TRANSDUCER

TECHNICAL FIELD

The present invention relates to utility meters, such as water meters or meters for gas or electric service. The invention more particularly relates to a transducer for converting mechanical movements, such as revolutions of a metering element to electrical pulses which can be conditioned to become digital signals.

DESCRIPTION OF THE BACKGROUND ART

An example of a prior metering pulse generator is illustrated and described in Strobel et al., U.S. Pat. No. 4,868,566, issued September 19, 1989, and assigned to the assignee of the present invention. A piezoelectric material is arranged as a thin, elongated layer on a cantilevered spring member. A tooth on a rotating sprocket contacts an extended end of the spring member to produce a bending movement, which is then followed by a rapid return movement. This generates a pulse signal which is amplified by an amplifier positioned on the spring member.

In this prior construction, the spring member provided a load on the torque of the meter mechanism. This can have an effect on accuracy of the meter at the low end of the flow measurement range. It would be desirable to reduce such torque loads as much as possible. While technologies such as optics eliminate mechanical loading, they introduce new issues such as batteries and other electrical power sources.

There are also known in the art of flow meters generally, a type of pulse generator utilizing magnetically switchable elements. Examples of such pulse generators are shown and described in Onoda et al., U.S. Pat. No. 4,265,127; Bohm et al., U.S. Pat. No. 4,579,008; Jerger et al., U.S. Pat. No. 4,793,192; Merriam, U.S. Pat. No. 5,311,581 and British Patent Specification GB2102129A. Many of these utilize magnetically

switchable elements, and a basic pulse generator is disclosed in U.S. Pat. No. 3,780,313.

5 The prior art does not provide a suitable metering pulse transducer for producing pulses that can be conveniently digitized and transmitted in networks for the collection of metering data. Such transducers should be compact and lightweight, and the prior art devices are not suitable in this respect, because they do not most efficiently utilize the principles of generating and sensing signals using the switchable magnetic elements. Such devices should be easy to
10 manufacture and low in cost, and many of the prior art devices are too expensive to manufacture or not sufficiently desirable for utility metering applications intended for the present invention.

15 SUMMARY OF THE INVENTION

The invention is embodied in a pulse transducer, which utilizes a compact rotor for carrying a plurality of magnetically switchable elements, and two magnets positioned adjacent the rotor for switching each element four times to
20 produce two pulses in one revolution of a rotor. A compact and efficient sensor is provided for sensing pulses generated by the switching of the magnetically switchable elements as they are moved into and out of the magnetic fields of the two magnets.

25 The rotor assembly of the present invention provides very little drag and consumes very little torque in mechanical drive mechanisms. The rotor can be used to directly drive a least significant digit analog meter dial, or it may be connected to a meter register drive train to provide digitized electrical signals at the same time as mechanical meter
30 movements are transmitted to a mechanical odometer or a mechanical register dial. The invention can also be embodied in a turbine-type flow meter, and other embodiments.

35 As compared with the prior art relating to switchable magnetic elements, the present invention is an improvement

over devices which include only a single switchable magnetic element, or a magnetic pickup associated with only a single magnetic element. The prior art does not utilize two magnets to produce a switching of each magnetic element four times to produce two pulses in one revolution of a rotor.

The present invention also effectively uses one sensor coil in association with the two magnets and a plurality of switchable magnetic elements in a compact arrangement.

In a preferred embodiment of the invention, the number of switchable magnetic elements is five, so that ten electrical pulses are produced for each revolution of the rotor. This corresponds to a decimal number readout device.

The prior art devices do not generate ten pulses per revolution of a rotor carrying the magnetic elements. Indeed, in many prior art devices, the magnets may be moved instead of the switchable elements. Unless ten pulses are produced per cycle or revolution, mechanical or electrical conversion is required to produce a decimal pulse count.

The invention provides a more compact device than the prior art, making it suitable for use in meter registers which are relatively small instruments.

The invention is disclosed in terms of meter registers for use in measuring water consumption, but may also find application in the metering of utilities such as gas or electricity, and or in other types instrumentation in which it is desired to convert mechanical movement to electrical pulses.

Other objects and advantages will be apparent to those of ordinary skill in the art from the description of the preferred embodiments which follow. In the description, reference is made to the accompanying drawings, which form a part hereof, and which illustrate examples of the invention. Such examples, however, are not exhaustive of the various embodiments of the invention, and therefore, reference is made to the claims which follow the description for determining the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a top plan view of a first two embodiments of the present invention;

Fig. 2A is a top plan view of a third embodiment of the present invention;

Fig. 2B is a sectional view taken in the plane indicated by line 2B -- 2B in Fig. 2A;

Fig. 3 is a top plan schematic view of a first variation of the embodiment of Fig. 1;

Fig. 4 is a sectional view in elevation of the embodiment of Fig. 3;

Fig. 5 is a top plan schematic view of a second variation of the embodiment of Fig. 1;

Fig. 6 is a sectional view in elevation of the embodiment of Fig. 5;

Fig. 7 is a schematic diagram of the operation of the embodiments of Figs. 1-6;

Fig. 8 is a circuit for conditioning pulses from the device of the present invention to output a 1-millisecond pulse; and

Fig. 9 is a longitudinal section view of a fourth embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 illustrates a top plan view of a meter register 10, which incorporates the present invention in two different embodiments shown in Figs. 3-4 and Figs. 5-6, respectively. The meter register 10 includes a dial face 11 with decimal numbers 12 arranged in a circle and a dial hand 13 which rotates around a central axis. An odometer 14 is provided by a plurality of number wheels for respective decimal places as illustrated.

In certain meter registers, it is possible to include a plurality of such analog dials, such as formed by elements 11, 12 and 13. One such analog dial is illustrated in Fig. 2A,

including dial face 15, indicia ring 16 and dial hand 17. A mechanism of the invention is shown in Fig. 2B. Such a mechanism can be connected to a dial hand 17 as shown in Fig. 2A, or it can be connected internally to a gear mechanism in the meter register 10 of Fig. 1, as shown more particularly in Figs. 3-6. In either type of meter register (Fig. 1 or Fig. 2), the mechanism of the present invention can be coupled to the mechanism for counting the least significant digit of utility consumption.

Referring now to Fig. 2B, the invention is provided by a rotor 20 having an axis of rotation 21 and having a plurality of switchable magnetic elements 22-26 equally and angularly spaced by seventy-two degrees (72°) around the axis of rotation 21 (Fig. 2A). The magnetically switchable elements 22-26 have a north-south polarity in a direction generally parallel to the axis of rotation 21.

The magnetically switchable elements 22-26 are more particularly of a type disclosed in U.S. Pat. No. 4,247,601, in which a wire of Vicalloy alloy is annealed, work hardened and then cut into shorter lengths to provide magnetic elements having a central core formed along its axis and an outer shell disposed around the central core. The shell and the core are made of material in which the magnetic domains can be switched under the influence of a magnetic field. As a result, the magnetic domains in the shell and the core can have the same magnetic polarity or an opposite magnetic polarity, in each of two directions, providing for four possible magnetic states. The wires are each 0.010 inches in diameter and 0.250 inches in length.

A sensor in the form of a coil 27 with 4000 turns of #43 AWG is wound around an annular carrier 28 of synthetic insulating material, sometimes called a "bobbin." As the switchable magnetic elements are switched a pulse will be induced in the coil 27, and from there transmitted through leads 38a, 38b.

Two permanent magnets 29, 30 are located adjacent the rotor 20 (Fig. 2B), in diametrically opposite positions in the

preferred embodiment, with each having a north (N) pole and a south (S) pole, such that their respective magnetic fields extend laterally to a region occupied by the switchable magnetic elements 22-26 in the rotor 20 (See Fig. 7). The two magnets 29, 30 are operated to switch the magnetic elements 22-26 as they pass by during rotation of the rotor 20.

A first one of the two permanent magnets 29 is disposed generally parallel to the axis of rotation 21 with its north (N) pole and its south pole (S) oriented in a first direction. A second one of the two permanent magnets 30 is disposed generally parallel to the axis of rotation 21 with its north pole (N) and its south pole (S) oriented in an opposite direction from the first one of the two permanent magnets 29. Each of the magnets 29, 30 has soft iron tabs 29a, 29b, and 30a, 30b, respectively, on top and bottom sides, the magnets 29, 30 being made in the form of cubes, and the tabs 29a, 29b, 30a and 30b being of a similar height and length, but of much narrower width than the faces of the cubes. The soft iron tabs 29a, 29b, and 30a, 30b tend to concentrate the flux emanating from the two permanent magnets 29, 30. Although permanent magnets 29, 30 are preferred, it would also be possible to use small electromagnets for elements 29 and 30.

When the rotor 21 is rotated, a plurality of electrical pulses are generated in the coil 27 for each revolution of the rotor 21, the plurality of electrical pulses being twice the number of magnetic elements 22-26 in the rotor 21. The pulses are transmitted through the leads 38a, 38b, seen in Fig. 2A to a circuit seen in Fig. 8.

The rotor 21 has a drive pawl 31 (Fig. 2B) formed in a cavity 32 on an underside to be engaged by various drive mechanisms to be described in relation to Figs. 3-6.

Figs. 3 and 4 show an arrangement, where the rotor 20 of Fig. 2B is driven by a magnetic pickup 33 having north (N) and south (S) poles. The magnetic pickup 33 rotates with a magnetic driver 34 having north (N) and (S) poles, which rotates with operation of a meter movement in a flow meter 35 in response to flow represented by an arrow in Fig. 4. This

magnetically coupled mechanical movement is coupled through the magnetic pickup 33 to a series of nine gears 36 mounted on respective gear shafts 37 (numbered "1" to "7", "8A" and "8B") in a gear mechanism, the last drive shaft "8A" carrying a capstan 39, which drives a toothed wheel 40, which in turn drives the least significant wheel 42 in an odometer 41, formed by a plurality of vertically arranged number wheels 42. The odometer 41 is preferably one of the type described in U.S. Pat. No. 5,376,776, issued December 27, 1994, and assigned to the assignee of the present invention.

A mechanism as described in relation to Fig. 2B is mounted on a rotating shaft 43 to be rotated with magnetic pickup 33. An electrical output signal is taken from the coil 27 and transmitted to electrical circuitry (not shown) to provide electrical pulses commensurate with the mechanical output of the flow meter 35. This electrical output in Figs. 3-4 is said to be unscaled because it is provided before the gear mechanism translates the raw meter movements to the counts of the odometer 42.

Figs. 5 and 6 show a scaled version of the invention. In the scaled version, a device as shown in Fig. 2B is coupled to the gear shaft 8A, which directly drives the capstan 39. This is the high resolution or scaled version because the rotor 20 will be rotated by meter movements through the gear mechanism which drives the odometer 42. The operation of the flow meter 35, the magnetic driver 34 and the magnetic pickup is the same as described in relation to Fig. 4.

An advantage of the present invention is that the assembly of the rotor 20, the coil assembly 27, 28 and the magnets 29, 30 provides very little drag and consumes very little of the torque produced in the mechanical gearing system.

Fig. 7 shows more particularly how the domains in one of the magnetic elements 22 are switched as they are rotated past the magnets 29, 30. The dot represents a direction out of the plane of the drawing, while an "x" represents a direction into the plane of the drawing. In position #1, as the rotor 20

rotates, element 22 travels along path of travel 53 toward the first magnet 29, the domains in the core 22a of the magnetically switchable elements 22-26 (only one of which is shown in Fig. 7) have a polarity represented by an "x", while the domains in the shell 22b have a polarity represented by dots (opposite the polarity of the core). When the element 22 moves into position #2, in the strongest portion of the H field 50 provided by magnet 29 (N polarity), the domains in the shell 22b will switch to a like polarity with the domains in the core 22a under the strong influence of the H field 50.

The rotor (not shown) will next rotate until the magnetically switchable element 22 reaches position #3, away from the H field 50 of the magnet 29 and an approaching the H field 51 of the S-oriented magnet 30. In position #3, the domains in the core 22a will switch to a polarity opposite the domains 22 in the shell 22b. In position #4, in the strongest portion of H field 51 of the S-oriented magnet 30, the domains in the shell 22b will switch to a direction the same as the direction of the domains in the core 22a, but opposite from the direction of second position, due to the opposite polarity of the magnet 30. When the rotor 20 then rotates back to the position #1, away from the H field 51 of the magnet 30 and approaching the N-oriented magnet 29, the domains in the core 22a will switch polarity to a polarity opposite the domains in the shell 22b.

The four magnetic switching events produce two electrically induced pulses for each magnetic element 22-26 for each revolution of the rotor 20. The switching produces pulses of twenty microseconds at the sensor coil 27. These pulses are transmitted to a pulse conditioning circuit 60 seen in Fig. 8, for translating the pulses into 1-millisecond square wave pulses.

When the domains of the core are switched under the influence of one of the magnetic fields of magnets 29 and 30, they are switched with a sudden and dramatic effect referred to as an avalanche effect. This induces a relatively significant voltage in the sensor coil 27, on the order of 2

AC volts (0 to peak) and approximately twenty microseconds in pulse width. The pulses will alternate between positive and negative polarity. The coil 27 is electrically connected to a full wave bridge rectifier 61 (Fig. 8). A resistor 62 and a capacitor 63 of suitable values are connected across the output of the rectifier 61, which is also connected to a gate on a N-type FET (field effect transistor) 64. The capacitor 63 is charged by the output of the rectifier 61, and then discharges through the NFET 64 to increase the output pulse width to about one millisecond. The NFET 64 provides an open drain connection 65 to a connecting device, which may be a counter with a display, or may be a data collecting device for retransmitting the data over networks. The assignee of the present invention offers such data collecting and retransmitting devices under the trade designations TRACE®, ACCESSplus® and DIALOG®. Each pulse represents a unit or fractional part of a unit of utility consumption.

Referring to Fig. 9, the invention can also be applied to a turbine-type flow meter 70. This meter 70 is mounted in a section of pipe 71, preferably on the order of one to two inches in diameter, which acts as a meter housing. A sensor coil 72 is disposed around the outside of the pipe or housing 71, in a carrier 73 that may be made integral with pipe 71 may be mounted on the pipe 71. The sensor coil 71 has leads (not shown) connecting it to a circuit as previously described in relation to Fig. 8. A pair of magnets 74 and 75 are disposed diametrically across the pipe 71 to produce the H-fields discussed above.

A turbine-type rotor 76 is mounted in the pipe 71 in the flow stream. The rotor 76 has blades 78 and a number of switchable magnetic elements 77, as described for the other embodiments above, preferably five, are mounted in respective blades 78 for rotation past the magnets 74 and 75. The rotor 76 is mounted by a bushing 79 on a bearing sleeve 80 attached to a shaft 81. The shaft 81 is has its opposite ends mounted in two hangers 82 and 83 which are attached at certain locations to the interior of the pipe 71, but have flow

passages 84 between fins 85, so that fluid can flow through the meter. Also shown are an upstream deflector 86 or hub and a downstream deflector 87 or hub, which are mounted on the shaft 81 and which are typical parts of turbine meters of this type. The flow of fluid through the device causes rotation of the rotor 76, and ten pulses are produced in the coil 72 for each revolution of the rotor 76.

The above description of several detailed embodiments provides several examples of the invention. For a definition of these and other embodiments which come within the scope of the invention reference is made to the claims which follow.

CLAIMS

I claim:

1. A pulse transducer, comprising:

a rotor having an axis of rotation and having a plurality of magnetically switchable elements spaced around its axis and rotatable and movable along a path of travel, each of said magnetically switchable elements having at least four magnetic states;

a sensor disposed adjacent said rotor for carrying magnetically produced electrical pulses;

two magnets disposed adjacent said sensor to produce magnetic fields of opposite polarity along the path of travel for the plurality of magnetically switchable elements; and

wherein as said rotor is rotated, said two magnets cause each of said magnetic elements to be magnetically switched through the four magnetic states to produce two electrical pulses in the sensor for each revolution of the rotor.

2. The pulse transducer of claim 1, wherein the plurality of magnetically switchable elements in the rotor includes five magnetically switchable elements, and wherein ten electrical pulses are produced for one revolution of the rotor.

3. The pulse transducer of claim 2, wherein the plurality of magnetically switchable elements are equally and angularly spaced around the axis of rotation.

4. The pulse transducer of claim 1, wherein each magnetically switchable element in the rotor has a core which is magnetically switchable between two polarity states and a shell which surrounds the core and is magnetically switchable between two polarity states to provide four magnetic states for each magnetically switchable element.

5. The pulse transducer of claim 1, wherein the plurality of magnetically switchable elements are equally and angularly spaced around the axis of rotation.

6. The pulse transducer of claim 1, wherein the two magnets are stationary.

7. The pulse transducer of claim 6, wherein the two magnets are positioned diametrically across the rotor.

8. The pulse transducer of claim 1, wherein the two magnets are positioned diametrically across the rotor.

9. The pulse transducer of claim 1, wherein the sensor includes a coil of wire encircling the rotor.

10. The pulse transducer of claim 9, further comprising a carrier encircling the rotor on which the coil of wire is carried.

11. The pulse transducer of claim 1, wherein the two magnets are permanent magnets.

12. The pulse transducer of claim 1, wherein the rotor is coupled to a dial hand that rotates around a dial face having decimal numbers.

13. The pulse transducer of claim 1, wherein the rotor is coupled to a plurality of odometer number wheel through a drive mechanism.

14. The pulse transducer of claim 1, wherein the rotor of the pulse transducer is coupled to a magnetic pickup for responding to rotation of a corresponding magnetic driver in a flow meter.

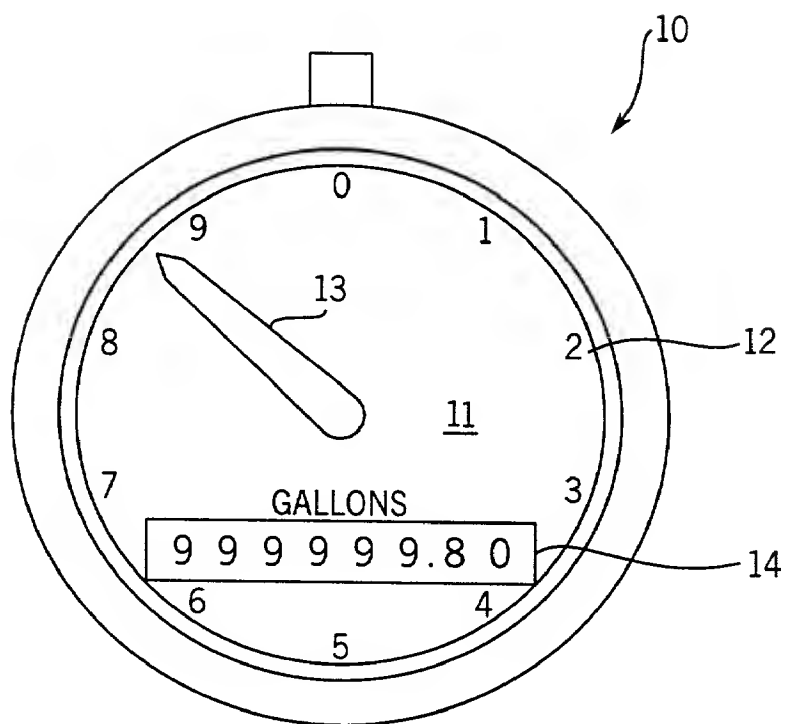
15. The pulse transducer of claim 14, wherein the rotor is coupled through a gearing arrangement to the magnetic pickup for response to a flow meter, and wherein said gearing arrangement also couples said magnetic pickup to an odometer in a meter register.

5

ABSTRACT OF THE DISCLOSURE

A metering pulse transducer for utility meters, including meters for water, gas and electric service, includes a rotor (20) with five magnetically switchable elements (22-26) spaced around the axis of rotation (21), a sensing coil (27) disposed around the rotor (20), and two permanent magnets (29, 30) disposed diametrically across the rotor (20) and positioned with equal and opposite polarity such that their magnetic fields (51, 52) extend laterally to reach the path of travel (53) of the magnetically switchable elements (22-26), such that when the rotor is rotated, electric pulses are generated as a result of the magnetically switchable elements (22-26) passing the permanent magnets (29, 30). A rotor (20) having five switchable magnetic elements (22-26) disposed seventy-two degrees (72°) apart generates ten pulses per revolution of the rotor (20). The rotor (20) can be used to directly drive a "least significant digit" analog meter dial, or it may be connected to a meter register drive train (36, 37), or may be used in a turbine-type meter (70).

FIG. 1



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FIG. 2A

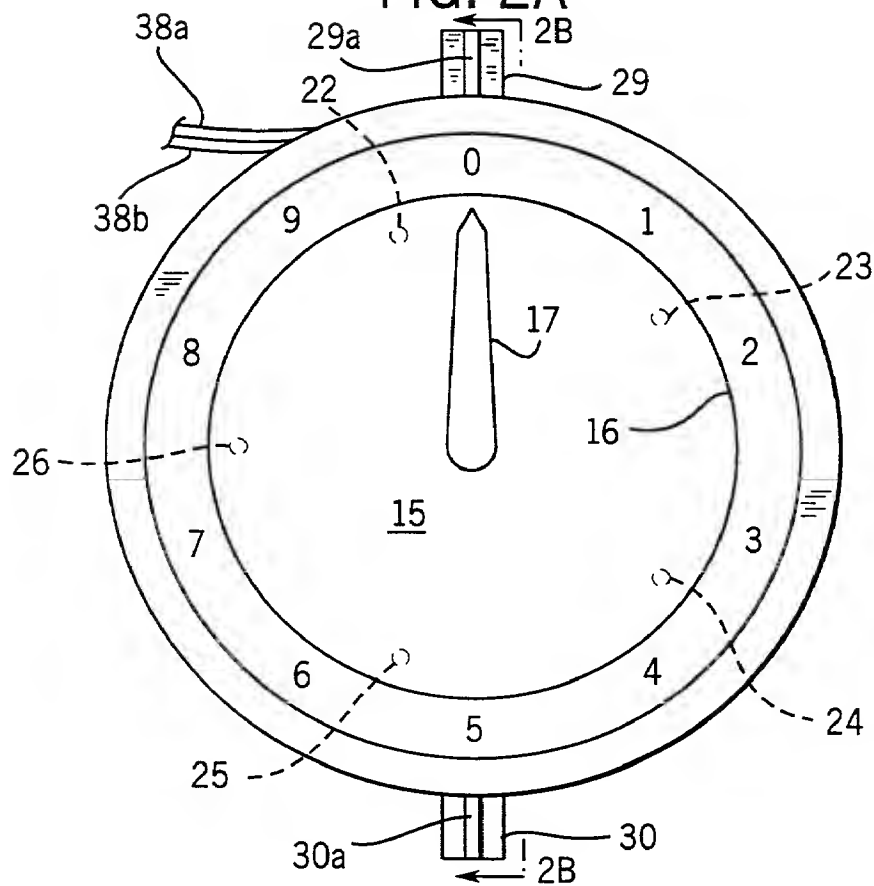
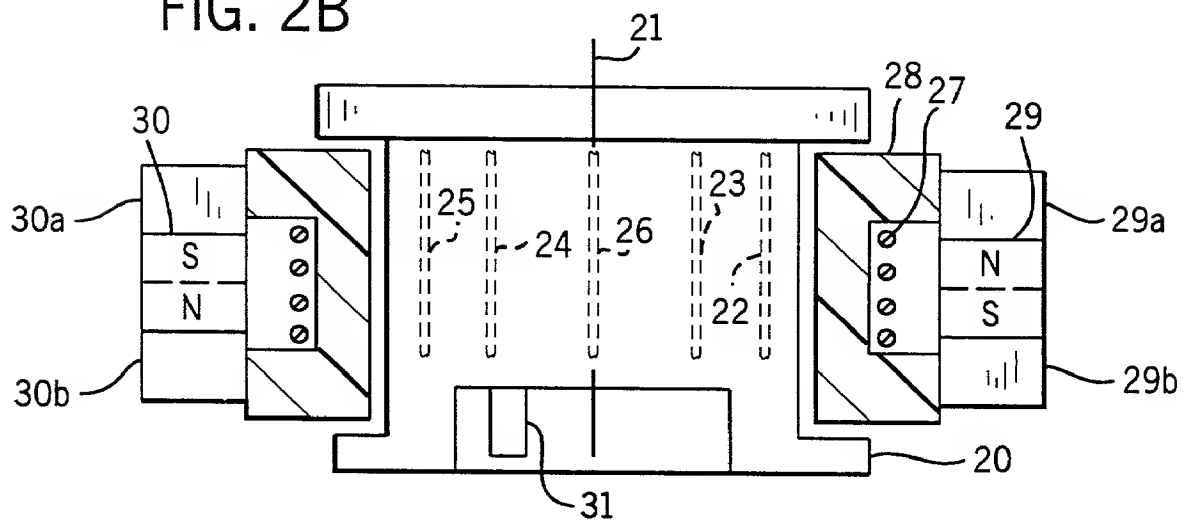


FIG. 2B



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FIG. 3

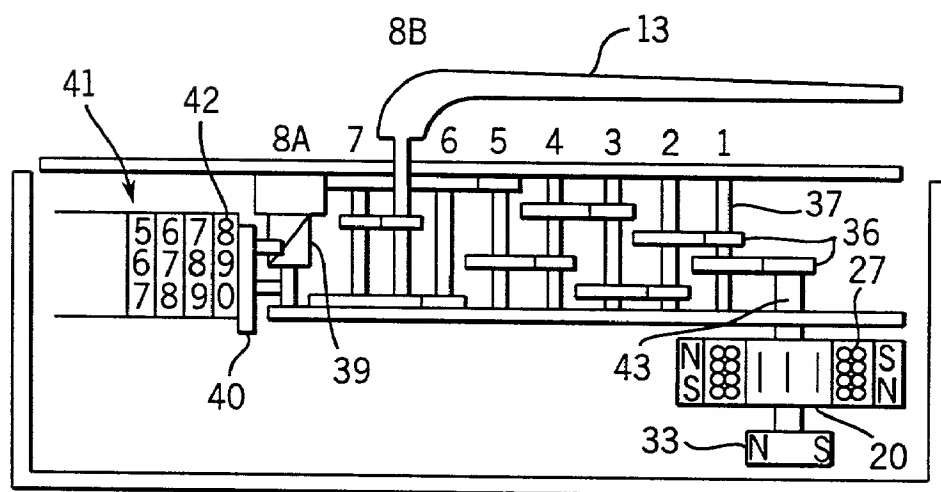
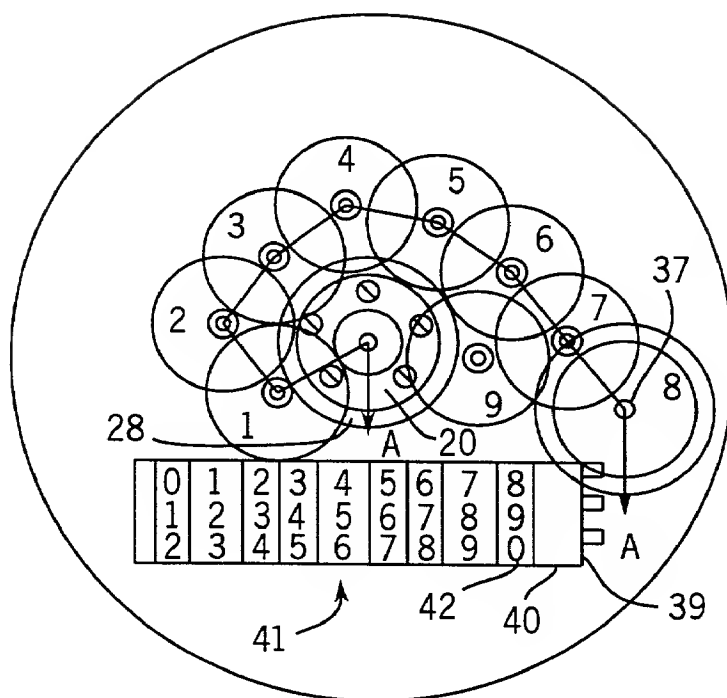


FIG. 4

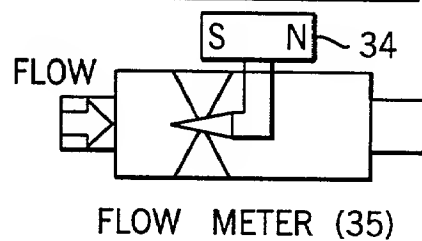


FIG. 5

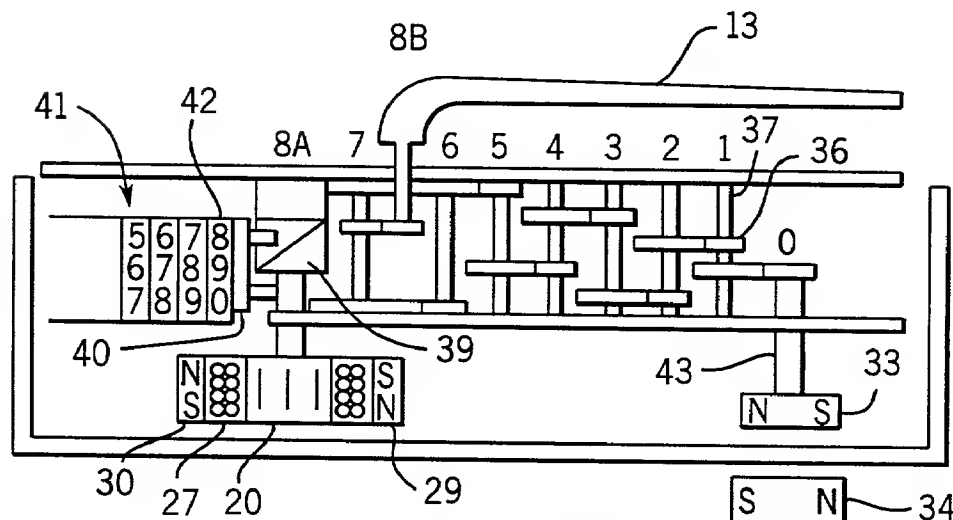
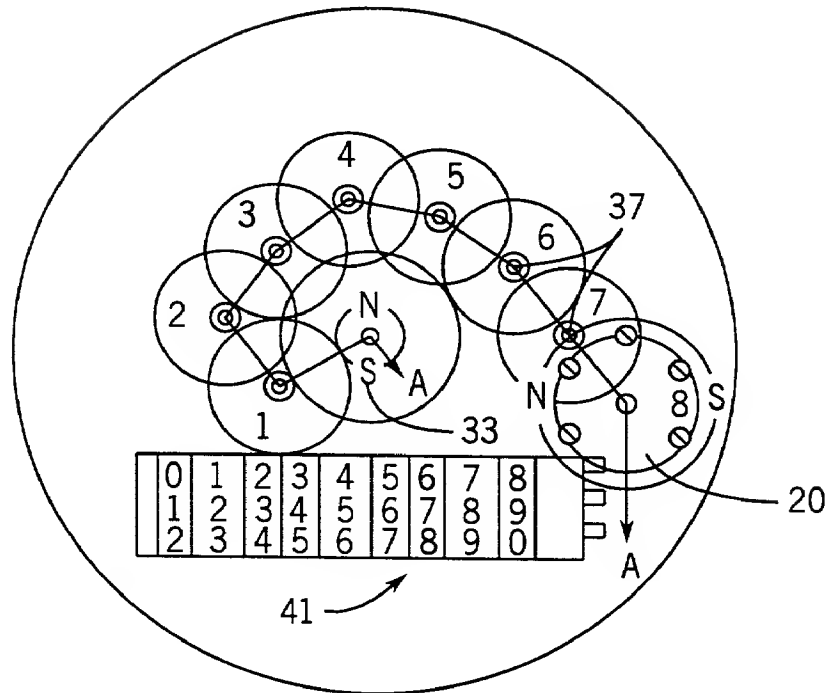
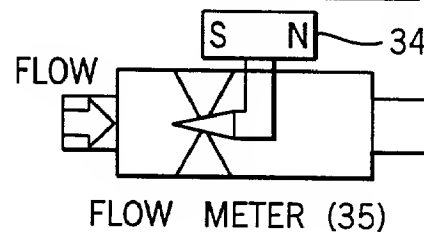


FIG. 6



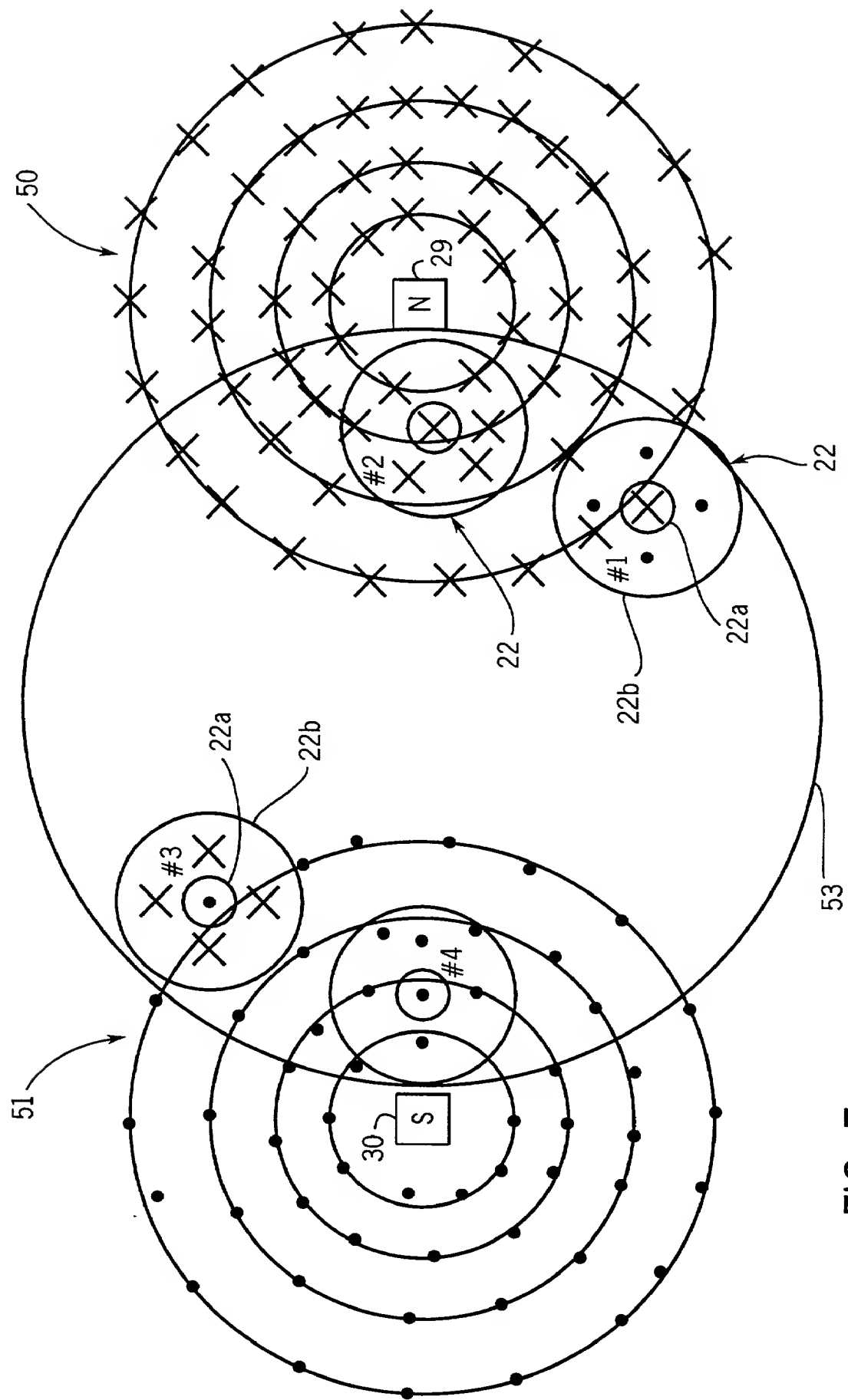


FIG. 7

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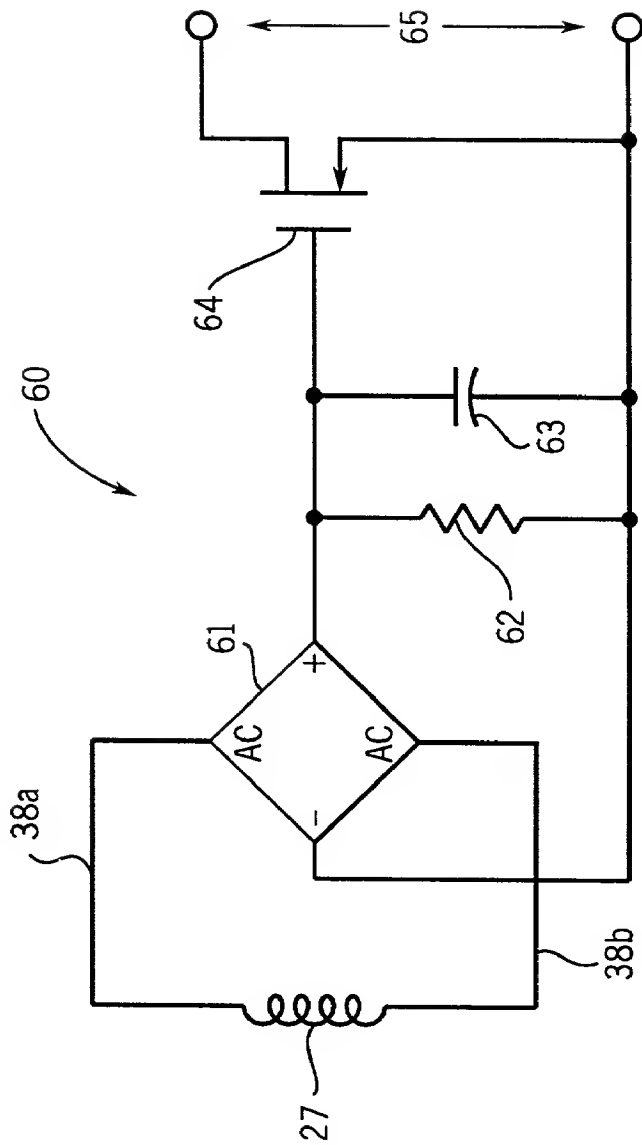


FIG. 8

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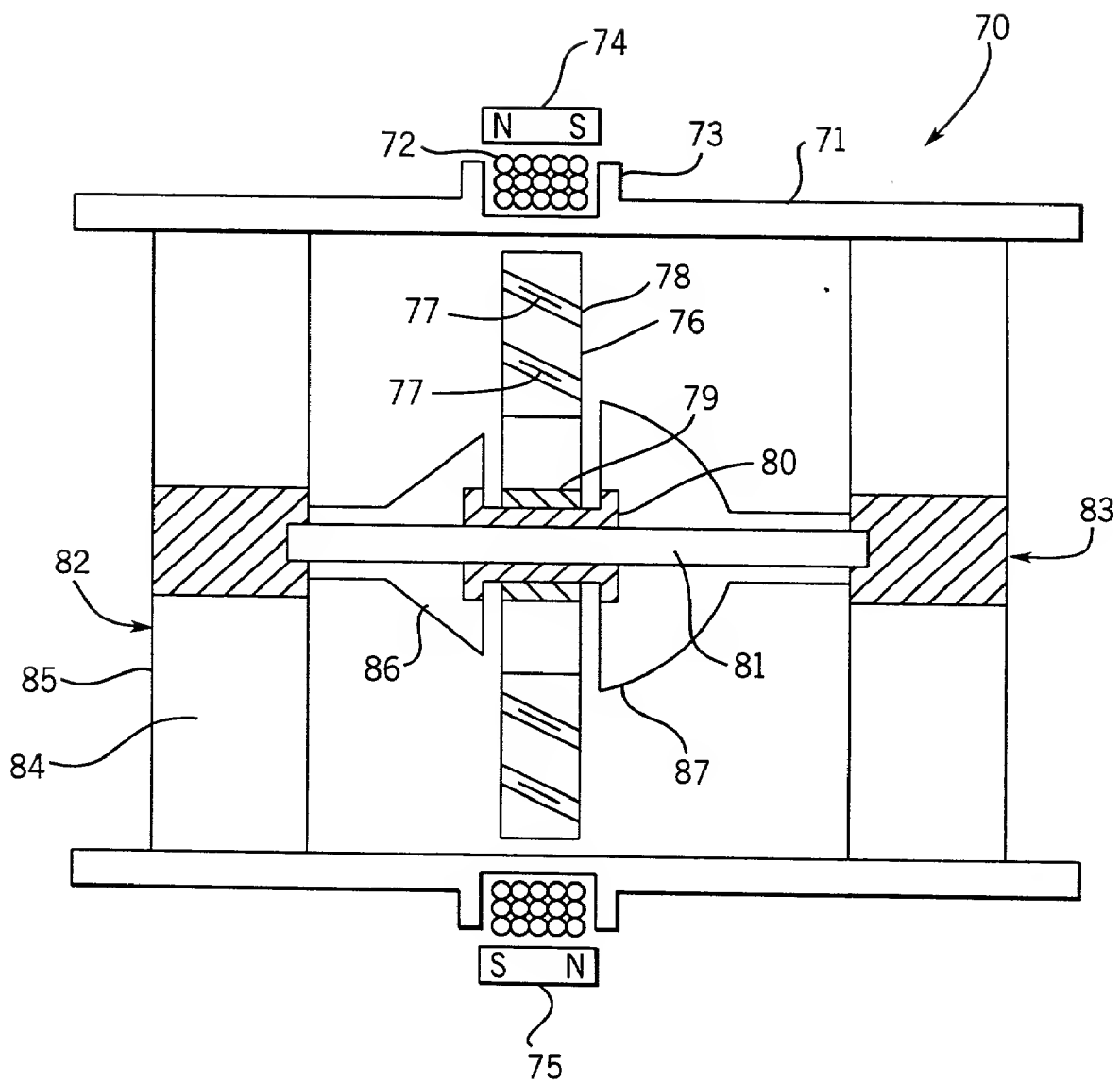


FIG. 9

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0010/PTO Rev. 6/95 U. S. Department of Commerce Patent and Trademark Office DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION <input checked="" type="checkbox"/> Declaration Submitted with Initial Filing OR <input type="checkbox"/> Declaration Submitted after Initial Filing	Attorney Docket Number	140315.92289
	First Named Inventor	Ray J. Thornborough
	COMPLETE IF KNOWN	
	Application Number	
	Filing Date	Herewith
	Group Art Unit	
	Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METERING PULSE TRANSDUCER

(Title of the Invention)

the specification of which

☒ is attached hereto

OR

☐ was filed on (MM/DD/YYYY)

as United States Application Number or PCT International

Application Number and was amended on (MM/DD/YYYY)

(if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code §119(a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate or §365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or any PCT international application having a filing date before that of the application on which priority is claimed.

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			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

☐ Additional foreign applications numbers are listed on a supplemental priority sheet attached hereto:

I hereby claim the benefit under Title 35, United States Code §119(e) of any United States provisional application(s) listed below.

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DECLARATION

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I hereby claim benefit under Title 35, United States Code §120 of any United States application(s), or §365(C) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application or PCT international application in the manner provided in the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application Number	PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority sheet attached hereto

As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and all continuation and divisional applications based thereon, and to transact all business in the Patent and Trademark Office connected therewith:

☐ Firm Name Customer Number or label
OR
☒ List attorney(s) and/or agent(s) name and registration number below

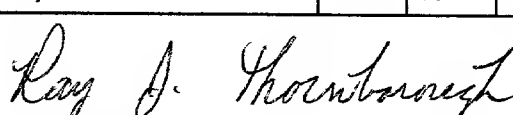
Name	Registration Number	Name	Registration Number
Neil E. Hamilton	19,869	Jean C. Baker	35,433
Thomas W. Ehrmann	20,374	David G. Ryser	36,407
Barry E. Sammons	25,608	Bennett J. Berson	37,094
J. Rodman Steele	25,931	Michael A. Jaskolski	37,551
Nicholas J. Seay	27,386	Allen J. Moss	38,567
George E. Haas	27,642	Richard T. Roche	38,599
Michael J. McGovern	28,326	Sherry Whitney	39,422
Carl R. Schwartz	29,437	Mark D. Passler	40,764
Gregory A. Nelson	30,577	Scott D. Paul	42,984
Keith M. Baxter	31,233	Daniel G. Radler	43,028
John D. Franzini	31,356	Steven J. Wietrzny	44,402
Joseph W. Bain	34,290		
Robert J. Sacco	35,667		

☐ Additional attorney(s) and/or agents named on a supplemental priority sheet attached hereto

Please direct all correspondence to ☐ Customer Number or label OR ☒ Fill in correspondence address below

Name	Michael J. McGovern		
Address	Quarles & Brady LLP		
Address	411 East Wisconsin Ave. Suite 2040		
City	Milwaukee	State	WI
Zip	53202-4497		
Country	USA	Telephone	(414) 277-5000
Fax	(414) 271-3552		

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Name of Sole or First Inventor:				A petition has been filed for this unsigned inventor	
Given	Ray	Middle	J.	Family	Thornborough
Inventor's Signature					Date
Residence:	Menomonee Falls	State	WI	Country	US
Citizenship	US				
Post Office					
Post Office	N89 W17625 St. Thomas Drive				
City	Menomonee Falls	State	WI	Zip	53051
Country	US				Applicant Authority
<input type="checkbox"/> Additional inventors are being named on supplemental sheet(s) attached hereto					